

## Claims

1. Apparatus for providing optical radiation comprising a pump source and at least one first amplifying waveguide, CHARACTERISED IN THAT the first amplifying waveguide emits optical radiation in excess of 1400nm when pumped by the pump source.

2. Apparatus according to claim 1 in which the pump source includes a plurality of laser diodes and at least one second amplifying waveguide, wherein the first amplifying waveguide is pumped by the second amplifying waveguide, and the second amplifying waveguide is pumped by the laser diodes, the apparatus being characterised in that the second amplifying waveguide is configured to improve the beam quality of radiation emitted by the laser diodes.

3. Apparatus according to claim 2 in which the pump source includes at least one multimode beam combiner for combining optical radiation emitted by the laser diodes.

4. Apparatus according to claim 2 or claim 3 and including at least one first beam combiner for combining optical radiation emitted by the second amplifying waveguides.

5. Apparatus according to any one of claims 2 to 4 in which the first amplifying waveguide comprises a first optical fibre.

6. Apparatus according to claim 5 in which the first optical fibre comprises a region containing a first rare-earth dopant.

7. Apparatus according to claim 6 in which the first rare earth dopant is selected from the group comprising erbium, holmium and thulium.

8. Apparatus according to claim 7 in which the first rare earth dopant is co-doped with ytterbium.

1           9.     Apparatus according to any one of claims 6 to 8 in which the first rare-  
2 earth dopant is pumped substantially at the peak of its absorption band.

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4           10.    Apparatus according to any one of claims 5 or claim 9 in which the first  
5 optical fibre comprises a core and a cladding.

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7           11.    Apparatus according to any of claims 5 to 10 in which the first optical  
8 fibre is single mode.

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10          12.    Apparatus according to any of claims 5 to 10 in which the first optical  
11 fibre is multi mode.

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13          13.    Apparatus according to any one of claims 5 to 12 in which the first  
14 optical fibre comprises a plurality of cores.

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16          14.    Apparatus according to any one of claims 2 to 13 in which the second  
17 amplifying waveguide comprises a second optical fibre.

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19          15.    Apparatus according to claim 14 in which the second optical fibre  
20 comprises a region containing a second rare-earth dopant.

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22          16.    Apparatus according to claim 14 or claim 15 in which the second  
23 optical fibre comprises a core and a cladding.

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25          17.    Apparatus according to any one of claims 14 to 16 and comprising a  
26 grating written into at least one of the core and the cladding.

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28          18.    Apparatus according to any one of claims 14 to 17 in which the second  
29 optical fibre is single mode.

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31          19.    Apparatus according to any of claims 14 to 18 in which the second  
32 optical fibre is multi mode.

1           20.    Apparatus according to any one of claims 14 to 19 in which the second  
2 optical fibre comprises a plurality of cores.

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4           21.    Apparatus according to any one of claims 2 to 20 in which the  
5 apparatus includes means to change the wavelength of radiation emitted by the  
6 second amplifying waveguide.

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8           22.    Apparatus according to claim 21 in which the means is a wavelength  
9 tuneable reflector, an optical switch, a source of optical radiation, or a tuneable  
10 grating.

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12          23.    Apparatus according to claim 22 in which the tuneable grating is  
13 thermally tuned, or tuned by an actuator.

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15          24.    Apparatus according to any one of claims 2 to 23 configured such that  
16 the optical radiation emitted by the first amplifying waveguide has a higher  
17 brightness when the second amplifying optical fibre emits at a first wavelength.

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19          25.    Apparatus according to claim 1 in which the pump supplies pump  
20 radiation for in-band pumping the first amplifying waveguide.

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22          26.    Apparatus according to claim 25 in which both the pump wavelength  
23 and the wavelength of the optical radiation are between 1400nm and 2500nm.

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25          27.    Apparatus according to any one of the preceding claims in which the  
26 pump source comprises a broad stripe laser diode.

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28          28.    Apparatus according to any one of the preceding claims in which the  
29 optical radiation is coupled to a scanner.

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31          29.    Apparatus according to claim 28 and including a controller for  
32 synchronizing the optical radiation with the scanner.

1           30.    Apparatus according to any one of the preceding claims, and which is  
2 in the form of an amplifier, a laser, a master oscillator power amplifier, a Q-switched  
3 laser, a source of amplified spontaneous emission, or a continuous wave laser.  
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5           31.    Apparatus according to any one of claims 1 to 29 and which is in the  
6 form of a laser for material processing.